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COUNTY ATLAS SERIES
ATLAS C-6, PLATE 2 OF 9
BEDROCK GEOLOGY

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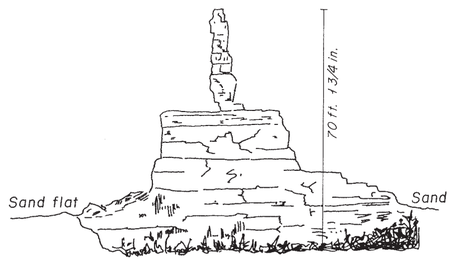
By

John H. Mossler

1990



CASTLE ROCK UNTIL 1883 AND ALL THAT REMAINS OF IT A CENTURY LATER

The singular pillar in Dakota County, known as Castle rock, consists of St. Peter sandstone. . . . [It is] *an outlier from which most of the formation has been removed over an area of some miles about . . . Near the base of the tower is a somewhat argillaceous layer, or one less firmly cemented, of a few inches, which weathers away faster than the rest, making the diameter there considerably less than above. Hence the tower has a threatening aspect, and the first impression of the beholder is the certainty that the first severe blast of wind will throw it from its place. . . .* [It has so] *invited the ambitious, but sacrilegious, carvings of visitors that a hole has been made through the body of the rock.*
— N.H. Winchell
Reprinted from the First Annual Report in volume II of the Final Report of the Geological and Natural History Survey of Minnesota (1888), p. 78-79.

ERA	SYSTEM/SERIES	FORMATION OR GROUP NAME	MAP SYMBOL	GENERAL LITHOLOGY	NATURAL GAMMA LOG (increasing count)	THICKNESS (in feet)
PALEOZOIC	MIDDLE ORDOVICIAN (458–453 m.y. ago)	DECORAH SHALE	Od			0 to 90
		PLATTEVILLE & GLENWOOD FORMATIONS	Opg			28 to 31
		ST. PETER SANDSTONE	Osp			128 to 160
	LOWER ORDOVICIAN (505–478 m.y. ago)	PRAIRIE DU CHIEN GROUP	Opc			145 to 308
		JORDAN SANDSTONE	€j			70 to 125
		ST. LAWRENCE FORMATION				
	UPPER CAMBRIAN (523–505 m.y. ago)	FRANCONIA FORMATION	€sf			187 to 240
		IRONTON & GALESVILLE SANDSTONES	€ig			21 to 63
		EAU CLAIRE FORMATION	€e			78 to 118
		MT. SIMON SANDSTONE	€m			155 to 275
	MIDDLE PROTEROZOIC, UNDIVIDED (1200–900 m.y. ago)		NOT SHOWN			

NOT EXPOSED IN DAKOTA COUNTY

LIMESTONE
DOLOSTONE
SANDY
SHALE
SANDY
SILTSTONE
SANDSTONE
MEDIUM TO COARSE
FINE TO VERY FINE
BASALT

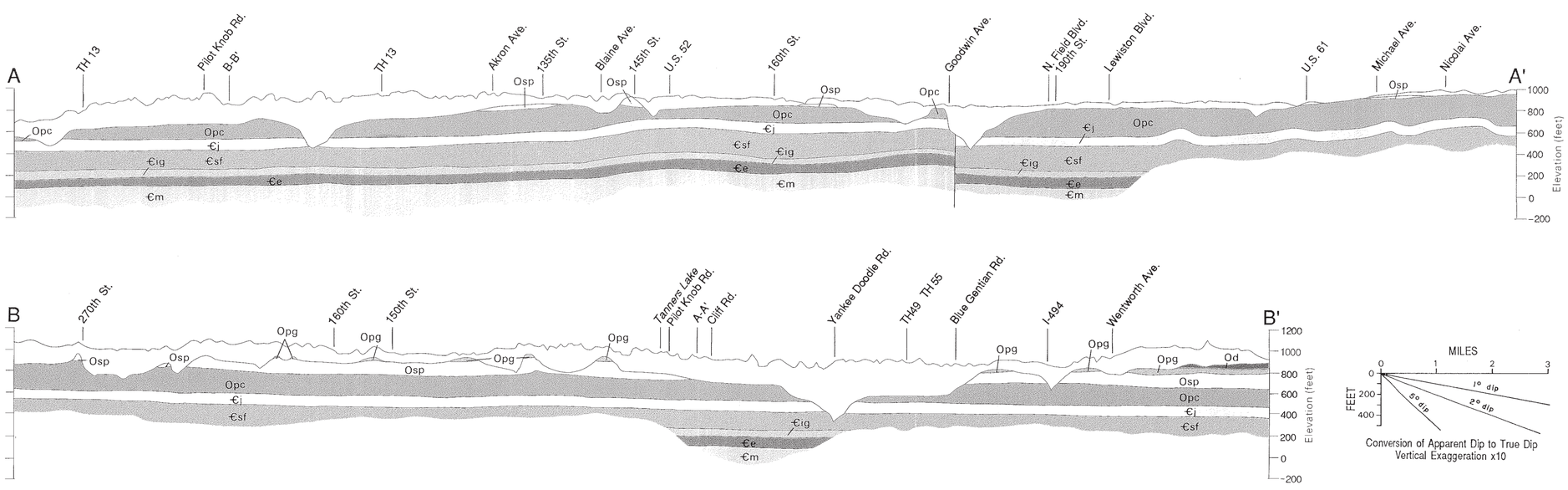
Fossils
Calcareous
Dolomitic
Glauconitic
Quartz pebbles, granules
Oolites
Chert
Cross bedded
Contact marks a major erosional surface

Base modified from U.S. Geological Survey, Faribault, Hastings, and St. Paul, 1985.
Cartography by Richard B. Darling

SCALE 1:100 000

1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS
1 0 1 2 3 4 5 MILES
5000 0 5000 10000 15000 20000 25000 FEET

Every possible effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Geological Survey in St. Paul. In addition, every effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.



DESCRIPTION OF BEDROCK UNITS

Od DECORAH SHALE—Green, calcareous shale with thin interbeds of limestone. Largely restricted to the extreme northern part of county where it attains a maximum thickness of 90 feet

Opg PLATTEVILLE AND GLENWOOD FORMATIONS—Fine-grained dolostone and limestone of the Platteville Formation is underlain by green, sandy shale of the Glenwood Formation. They underlie the Decorah Shale and are distributed throughout much of Dakota County. Many small flat-topped mesas capped with Platteville occur in southeastern Dakota County. Platteville rocks range in thickness from 28 feet at the northern border to 18 feet in southeastern Dakota County. Shale of the Glenwood Formation is 2.5 to 3.0 feet thick in northern Dakota County and is reported to be 10 feet thick near the southeastern border

Osp ST. PETER SANDSTONE—Upper half to two thirds is fine- to medium-grained quartzose sandstone that generally is massive to very thick bedded. The lower part contains multicolored beds of sandstone, siltstone, and shale with interbeds of very coarse sandstone. The base is a major erosional contact. The St. Peter subcrops throughout much of Dakota County. Outcrops, which are limited to beds of the upper part of the formation, occur chiefly on the flanks of small mesas that are capped by the Platteville Formation in southeastern Dakota County and in cliffs along the Mississippi River in Mendota Heights. The St. Peter ranges in thickness from 160 feet in the north to 128 feet in the southern part of Dakota County (see Fig. 2)

Opc PRAIRIE DU CHIEN GROUP—Dolostone of the Shakopee Formation forms the upper two thirds to half. It is commonly thin bedded and sandy or oolitic, and contains thin beds of sandstone and chert. Dolostone in the lower part—the Oneota Dolomite—is commonly massive to thick bedded, and generally is not oolitic or sandy, except for a transitional zone just above the Jordan Sandstone. Dolostone of both formations is karsted, and the upper part, where the overlying formations have been removed by erosion, may be rubbly. The Prairie du Chien crops out along the Vermillion River in and near Hastings. There are some outcrops in low bluffs and roadcuts, and in ravines by the Mississippi River from near Nininger to west of Sedil and from Inver Grove Heights south. Many outcrops too small to show at the scale of this map occur in southeastern Dakota County. In northern Dakota County, east of Savage, the upper part of the Prairie du Chien is exposed in a large quarry. The Prairie du Chien ranges in thickness from 145 feet in extreme northern Dakota County by St. Paul to over 300 feet along the southern border of the county

€j JORDAN SANDSTONE—The upper part is medium- to coarse-grained, friable, quartzose sandstone that is trough cross-bedded The lower part is primarily fine-grained sandstone that commonly is feldspathic, massively bedded, and bioturbated. The upper contact with the overlying Prairie du Chien Group, which is sharp compared to its gradational nature farther south in Minnesota, is exposed in the bank of the Mississippi River at Nininger and at the outlet of Spring Lake

€sf ST. LAWRENCE AND FRANCONIA FORMATIONS—The St. Lawrence consists of dolomitic shale and siltstone that is generally thin bedded. The contact between it and overlying Jordan Sandstone is gradational. The Franconia is composed of thin-bedded, very fine grained glauconitic sandstone and minor shale. Some sandstone beds are massive and bioturbated; others are cross-bedded. The Franconia does not crop out in Dakota County, nor do underlying formations

€ig IRONTON AND GALESVILLE SANDSTONES—Silty, fine-to coarse-grained, poorly sorted, quartzose sandstone underlain by better sorted, fossiliferous, fine- to medium-grained sandstone. The upper contact with the Franconia is sharp

€e EAU CLAIRE FORMATION—Siltstone, very fine sandstone, and greenish-gray shale. Some sandstone beds are glauconitic. Minor dolomitic cement at the top of the formation. The contact with the overlying Galesville Sandstone is gradational. Shown only on the cross sections

€m MT. SIMON SANDSTONE—Chiefly fine to coarse, quartzose sandstone. The upper third contains many thin beds of well-sorted siltstone and very fine sandstone and is fossiliferous. The lower two thirds has fewer layers of fine-grained sandstone and consists primarily of medium- to coarse-grained sandstone. The basal part has poor to moderate sorting and contains thin layers of quartz and chert granules and pebbles. The basal contact is a major erosional surface. The upper contact with the Eau Claire is sharp and marked by a band of ferroan oolites in places. At the upper contact, the grain size increases markedly from the very fine of the Eau Claire, to fine to medium, to the very coarse of the Mt. Simon

MIDDLE PROTEROZOIC ROCKS, UNDIVIDED—The Solor Church Formation is the principal geologic unit underlying the Paleozoic rocks. It consists of reddish-brown shale interbedded with reddish-brown lithic and feldspathic sandstone. About 760 feet of Solor Church was penetrated in an exploratory test hole west of Rosemount. However, geophysical modeling indicates that as much as 4 km (13,200 feet) of Solor Church Formation may underlie the Twin Cities basin (Chandler and others, 1989) in northern and western Dakota County. East of the Empire fault, the Fond du Lac Formation is the first Proterozoic unit (Morey, 1977). It is a light-red to dark-reddish-brown, poorly sorted feldspathic sandstone containing interbeds of moderate to very dusky red shale. Along the Empire fault and the Vermillion anticline, Proterozoic basaltic and rhyolitic volcanic rocks are present beneath thin layers of Solor Church Formation that are only a few feet thick in some places. The Hinckley Sandstone, which is the uppermost Proterozoic sedimentary formation in the region, is absent in most of Dakota County. In the past, the basal part of the Mt. Simon Sandstone was sometimes mistaken for the Hinckley

MAP SYMBOLS

Geologic contact—Approximately located

Fault—Upthrown and downthrown blocks are labeled

Anticline—Showing crestline and direction of plunge

Syncline—Showing axis of the trough and direction of plunge

Dome

INTRODUCTION

A bedrock geologic map shows the geographic distribution of the geologic units that crop out or are covered only by unconsolidated materials. In the northern and western parts of Dakota County, the bedrock is covered by a mantle of unconsolidated Quaternary deposits that range to more than 500 feet in thickness in deeper buried valleys, but are thin or absent in some places along the valley of the present Mississippi River. In the southeastern and southern parts of the county, they are very thin and bedrock is exposed in many places; hills whose flat tops reflect a bedrock core capped by resistant Platteville Formation are common on the uplands.

The cross sections add the dimension of depth and illustrate stratigraphic and structural relationships among units. The geologic formations are relatively thin in relation to their geographic extent and would be only a tenth as thick as shown, if the vertical scale were the same as the horizontal. This vertical exaggeration distorts the regional, as well as the local slope or dip of the formations.

The considerable variations in thickness of unconsolidated formations overlying the bedrock and variations in elevation of the first bedrock formation are other features of the county's geology illustrated on the cross sections. Plate 4 of the atlas shows these variations in map form for the entire county. Knowledge about bedrock conditions generally decreases with depth below the land surface, because most of the geologic data were acquired during the drilling of water wells. In areas of thick overburden, it commonly is not necessary for well contractors to drill the entire thickness of unconsolidated overburden to find sufficient ground water. Therefore, the bedrock plate shows bedrock conditions within 200 feet more accurately than it shows conditions below 200 feet. Where little information is available on the lower formations, the geologic contacts on the cross sections are dashed. Virtually no information is available below the limits shown on the cross sections.

Plates 5 through 10 of this atlas demonstrate how information from the bedrock plate, combined with information about other geologic or hydrologic aspects of Dakota County, can be used to construct derivative maps that relate to problems of resource management in Dakota County. These plates are intended to assist citizens and county officials who are not geologists. The bedrock map is a valuable source of basic data that can be used to prepare additional interpretive maps as needs arise.

The bedrock geologic map is based partly on tabulated locations and lithology of bedrock outcrops in MGS files, and partly on the distribution of shallow bedrock areas as mapped by the Dakota County Soil Survey (Hundley, 1983). Much of the subsurface information used for this map was acquired during drilling of water wells or bore holes for engineering projects. These data are described on Plate 1 of this atlas. Seismic soundings by Vick and others (1980, 1980) were supplemented at selected localities by soundings done for this atlas by Andrew Streitz of the Minnesota Department of Natural Resources. The gamma log in the geologic column illustrates typical signatures of the formations; many wells were logged specifically for this atlas. Acquisition of subsurface data is a continuing process and each new data point adds to the store of knowledge about the subsurface geology of Dakota County. For this reason, as well as for greater detail, it is best to examine current data bases at MGS for site-specific geologic studies.

GEOLOGIC HISTORY AND STRUCTURE

All the bedrock units shown on the map are marine sedimentary rocks of Early Paleozoic age, a time when shallow seas covered southeastern Minnesota and parts of many adjacent states. Sand accumulated in near-shore bars, on beaches, and in sand dunes; silt and clay formed mud flats or settled out in quiet water farther from shore; and carbonate derived from remains of invertebrate shells and algae accumulated in small banks or reefs and as tabulate layers on the seafloor. These sediments were later lithified to form the sandstone, shale, and dolomitic limestone of today.

After deposition of the Prairie du Chien Group, the marine waters withdrew from the area long enough for dry land to form and for significant erosion to occur. However, deposition of St. Peter Sandstone on sedimentary rocks older than the Prairie du Chien, as observed in Hennepin County (Olsen and Bloomgren, 1989), cannot be demonstrated in Dakota County.

The regional dip of the Paleozoic strata toward the west and north reflects the position of Dakota County on the southeastern margin of the Twin Cities basin (Fiig. 1). The Twin Cities basin developed in Middle Ordovician time over an older basin that formed along a part of the Midcontinent rift. The rift now is a large geologic feature composed of thick lava flows and red clastic sedimentary rocks. Large-scale block faulting in these Proterozoic rocks caused the formation of an elongate northeast-trending basin, as a down-faulted block or graben, beneath what was to become the Twin Cities Metropolitan Area.

Much of the movement that deformed the Paleozoic rocks of the Twin Cities basin must have taken place after deposition of the Middle Ordovician rocks because the Platteville Formation, which was deposited at about the same depth within the shallow ocean, as inferred from its lithic uniformity, is found at elevations of 800 feet near the center of the basin in St. Paul and crops out at elevations higher than 1000 feet in southern Dakota County.

The Paleozoic Twin Cities basin, rather than a single down-faulted structure, is the result of many small folds and faults in step fashion. Individually they have small displacements of about 100 feet for folds and 50 to 150 feet for faults. Many of these faults and folds occur in eastern Dakota County along the margin of the Twin Cities basin. None are exposed there in outcrop, but they are inferred from subsurface data. They are shown on the map with standard geologic symbols. Two major structures are the Vermillion anticline and Empire fault (Jirsa and others, 1986). These structures and other folds are shown on cross section A-A'.

Although faults are not visible in outcrop in Dakota County, in neighboring Washington County, they cut outcrops of Prairie du Chien dolostone and Jordan sandstone in bluffs on the Mississippi River about a mile above Hastings (SE1/4 sec. 1, T. 26 N., R. 21 W.). Maximum displacement (throw) is nearly 100 feet in the larger of the two major faults exposed (Schwartz, 1936, p. 92).

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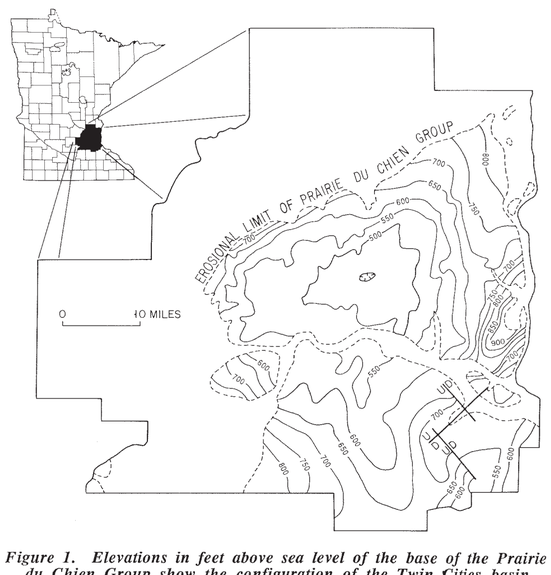

Figure 1. Elevations in feet above sea level of the base of the Prairie du Chien Group show the configuration of the Twin Cities basin.

GEOLOGIC ATLAS OF DAKOTA COUNTY, MINNESOTA